

What is claimed is:

1. A method of detecting a degradation of quality of service in a multicast tree in an application layer multicast network, the method comprising:
  - detecting at a child node in the multicast tree a degradation of quality of service associated with a service being received at the child node; and
  - determining whether the degradation of quality of service is resulting from a child-parent link or an upstream link in the multicast tree.
2. The method of claim 1, further comprising selecting a new parent node for the child node in response to detecting the degradation of quality of service is resulting from the child-parent link.
3. The method of claim 2, further comprising selecting a new parent node for a child node incident to the upstream link in response to detecting the degradation of quality of service is resulting from the upstream link.
4. The method of claim 1, further comprising:
  - transmitting a complaint to the parent node, the complaint indicating a degradation of quality of service at the child node;
  - receiving a list of a set of candidate nodes in response to the degradation of quality of service resulting from the child-parent link; and
  - selecting one of the candidate nodes as a new parent node for the child node.

5. The method of claim 4, further comprising constructing a new service path in the multicast tree including the child node and the new parent node.

6. The method of claim 5, wherein constructing a new service path further comprises:  
5 establishing a connection to the new parent node while maintaining a connection to the parent node;

synchronizing data received from the parent node and the new parent node; and  
terminating the connection to the parent node.

10 7. The method of claim 4, wherein selecting one of the candidate nodes as a new parent node for the child node comprises:

measuring distances to each of the candidate nodes;

determining a metric associated with the quality of service and each candidate node;  
and

15 selecting one of the candidate nodes that is closest to the child node and that is operable to satisfy at least one quality of service characteristic.

8. The method of claim 4, wherein each of the candidate nodes is physically close to the child node.

9. The method of claim 4, comprising:  
determining whether the complaint timed out;  
retransmitting the complaint to the parent node in response to the complaint timing out.

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10. The method of claim 1, wherein detecting at a child node a degradation of quality of service comprises detecting a measured quality of service characteristic associated with the received service falling below a predetermined threshold.

10 11. The method of claim 1, wherein detecting at a child node a degradation of quality of service comprises detecting degradation of quality of service as perceived by a user at the child node.

12. The method of claim 1, wherein quality of service includes at least one of a metric  
15 associated with processing data at a node receiving the service and a metric associated with transmitting data for the service between nodes in the multicast tree.

13. The method of claim 1, further comprising:  
determining at the parent node whether quality of service associated with the service is  
20 degraded;  
transmitting a complaint to the parent node's parent node in the multicast tree indicating a degradation of quality of service at the parent node in response to determining at the parent node that the quality of service is degraded; and

requesting a list of a set of candidate nodes from a global information table in response to determining at the parent node that the quality of service is not degraded, wherein each of the candidate nodes is operable to provide the service to the child node and is physically close to the child node.

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14. A method of determining location of degradation of quality of service in a multicast tree in an application layer multicast network, the method comprising:

receiving a complaint from a child node at a parent node in the multicast tree, the complaint indicating a degradation of quality of service of a service being received at the  
10 child node; and

determining whether a cause of the degradation of quality of service is located in an upstream link or is located at a child-parent link.

15. The method of claim 14, wherein determining whether a cause of the degradation of  
15 quality of service is located in an upstream link or is located at a child-parent link comprises:

determining at the parent node whether quality of service associated with the service being received at the child node is degraded;

transmitting a complaint to the parent node's parent node in the multicast tree indicating a degradation of quality of service at the parent node in response to determining at  
20 the parent node that the quality of service is degraded; and

requesting a list of a set of candidate nodes from a global information table in response to determining at the parent node that the quality of service is not degraded, wherein

each of the candidate nodes is operable to provide the service to the child node and is physically close to the child node.

16. The method of claim 15, wherein requesting a list of a set of candidate nodes from a  
5 global information table comprises transmitting location information for the child node to a distributed hash table overlay network storing the global information table.

17. The method of claim 16, wherein the global information table includes at least  
location information and information associated with services provided by nodes in the  
10 application layer multicast network.

18. The method of claim 17, wherein the global information table is stored in a plurality  
of distributed hash table nodes in the distributed hash table overlay network, such that each  
distributed hash table node stores information for nodes physically close in an underlying  
15 physical network.

19. The method of claim 18, wherein requesting a list of a set of candidate nodes from the  
global information table comprises hashing a landmark vector of the child node to identify a  
distributed hash table node to transmit a request for a set of candidate nodes for the child  
20 node.

20. The method of claim 15, wherein the global information table stores information for  
nodes transmitting a complaint, the method comprising:

searching the global information table for the set of candidate nodes such that the set of candidate nodes does not include a node that transmitted a complaint.

21. A method of determining whether to reconfigure a multicast tree in an application  
5 layer multicast network, the method comprising:

detecting an occurrence of a predetermined condition in the application multicast network, wherein the predetermined condition is stored in a global information table stored in distributed hash table nodes in the network; and

10 determining whether to reconfigure the multicast tree in response to detecting the occurrence of the predetermined condition.

22. The method of claim 21, wherein determining whether to reconfigure the multicast tree comprises determining whether reconfiguring the multicast tree improves quality of service for a node in the multicast tree.

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23. The method of claim 22, further comprising reconfiguring the multicast tree in response to determining that reconfiguring the multicast tree improves quality of service for a node in the multicast tree.

20 24. A node in a multicast tree, the node comprising:

means for detecting a degradation of quality of service associated with a service being received at the node; and

means for transmitting a complaint to a parent node of the node in the multicast tree, the complaint indicating a degradation of quality of service at the child node.

25. The node of claim 24, further comprising:

5 means for receiving a list of a set of candidate nodes in response to the degradation of quality of service resulting from a child-parent link; and  
means for selecting one of the candidate nodes as a new parent node for the child node.

10 26. The node of claim 25, further comprising:

means for receiving notification of an occurrence of a predetermined condition; and  
means for determining whether to reconfigure the multicast tree in response to the occurrence of the predetermined condition.

15 27. A parent node connected to a child node in a multicast tree, the parent node comprising:

means for receiving a complaint from the child node, the complaint indicating a degradation of quality of service of a service being received at the child node; and  
means for determining whether quality of service associated with the service is  
20 degraded at the parent node;

means for transmitting a complaint to the parent node's parent node in the multicast tree indicating a degradation of quality of service at the parent node in response to determining at the parent node that the quality of service is degraded; and

means for requesting a list of a set of candidate nodes from a global information table in response to determining at the parent node that the quality of service is not degraded, wherein each of the candidate nodes is operable to provide the service to the child node and is physically close to the child node.

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28. The parent node of claim 27, further comprising:

means for hashing location information for the child node to identify a location in a distributed hash table overlay network storing the global information table; and

means for transmitting the location information with a request for a list of a set of 10 candidate nodes with the location information to the identified location.

29. The parent node of claim 28, wherein the global information table includes at least location information and information associated with services provided by nodes in a network including the multicast tree.

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30. The parent node of claim 29, wherein the global information table is stored in a plurality of distributed hash table nodes in the distributed hash table overlay network, such that each distributed hash table node stores information for nodes physically close in the network.

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31. Computer software embedded on a computer readable medium, the computer software comprising instructions performing:

detecting at a child node in a multicast tree a degradation of quality of service associated with a service being received at the child node; and  
determining whether the degradation of quality of service is resulting from a child-parent link or an upstream link in the multicast tree.

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32. The computer software of claim 31 comprising instructions performing:  
selecting a new parent node for the child node in response to detecting the degradation of quality of service is resulting from the child-parent link.
  
- 10 33. The computer software of claim 31 comprising instructions performing:  
selecting a new parent node for a child node incident to the upstream link in response to detecting the degradation of quality of service is resulting from the upstream link.
  
- 15 34. The computer software of claim 31 comprising instructions performing:  
transmitting a complaint to the parent node, the complaint indicating a degradation of quality of service at the child node;  
receiving a list of a set of candidate nodes in response to the degradation of quality of service resulting from the child-parent link; and  
selecting one of the candidate nodes as a new parent node for the child node.

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35. Computer software embedded on a computer readable medium, the computer software comprising instructions performing:

detecting an occurrence of a predetermined condition in the application multicast network, wherein the predetermined condition is stored in a global information table stored in distributed hash table nodes in the network; and

determining whether to reconfigure the multicast tree in response to detecting the  
5 occurrence of the predetermined condition.

36. The computer software of claim 35 comprising instructions performing:  
determining whether reconfiguring the multicast tree improves quality of service for a  
node in the multicast tree; and  
10 reconfiguring the multicast tree in response to determining that reconfiguring the  
multicast tree improves quality of service for a node in the multicast tree.